Remarks

General

The specification has been amended editorially to correct typographical errors. Claim 1, 2, 4 to 7, 10, 12, 14 to 18, 20, 22 to 26, 28, and 29 are pending. Claim 3, 8, 9, 11, 19, 21, and 30 have been cancelled. Claim 13 and 27 have been amended to clarify the logical relationship among elements. The dependent claim 26 incorporates all the subject matter of the parent Claim 17, and Claim 22 which provides the proper antecedence for the "said substrate".

Background information – Diffractive grating and Fresnel zone plate are different optical devices

Prior to discussing the objection to rejections, the Applicant will first provide the essential background information distinguishing the novelty of the present invention and its unobviousness over the cited references.

Diffraction grating and Fresnel zone plate are different optical devices. They have very different structural designs, and possess substantially different optical properties.

– *Diffraction grating*

A diffraction grating is a *linear* optical device consisting of a number of *periodic* reflecting or transmissive surfaces. The reflecting surfaces, as shown in Figure 1a, are usually in the form of elongated ribbons. These elongated ribbons are arranged one next to the other along the x-direction in such a way that the longer sides of the ribbons are parallel to each other. Therefore along the x-direction, a *periodic structure* with a periodicity W = W1 + W2 is formed, where W1 and W2 are the widths of Element 1, and Element 2 respectively.

Referring to Figure 1b, the most important feature of a diffraction grating is that when the grating is illuminated in the normal direction by a plane wave 4, the diffraction grating generates +1 order diffracted *plane wave* 6 and –1 order diffracted *plane wave* 8 at an angle θ as determined by the grating equation:

$$W\sin(\theta) = n\lambda$$

where λ is the wavelength of the illumination, and n is the diffraction order.

– *Fresnel zone plate*

A Fresnel zone plate is a *symmetrical circular* optical device consisting of a series of *concentric circular* zones as shown in Figure 2a. The widths of the

zones *are not equal* as in the case of diffraction gratings. Instead, the radii of the zones are determined by the zone plate equation:

$$R_n = \sqrt{n\lambda F + \frac{n^2\lambda^2}{4}}$$

Where R_n is the radius of the nth zone, λ is the wavelength of the illumination, and F the focal length of the zone plate.

The most important feature of a Fresnel zone plate is that it is a *lens*. Accordingly, it is capable of forming images just as regular lenses. In particular, when a zone plate is illuminated in the normal direction by a plane wave, it forms a *focal point* along its optical axis at a distance of F from the center of the zone plate, as shown in Figure 2b.

The fact that a zone plate is a lens has been clearly documented in many references such as the article by R.W. Wood (R. W. Wood, *Philos. Mag.* V45, 51, 1898, which is provided with the IDS). In contrast, a diffraction grating can not function as a lens. Fresnel zone plates and diffraction gratings are *different* optical devices.

The Objection to the claim rejection as being anticipated under § 102 by Bloom et al

Claims 1-4, 14-16, 17-20, 22-24, and 28-29 were rejected under 35 USC 102(b) as being anticipated by the patent issued to Bloom et al (PN. 5,311,360).

The diffractive modulator taught by Bloom et al is based on *diffractive gratings*. The diffractive modulator comprises a plurality of equally spaced apart *grating elements*, each of which includes a light reflective planar surface. The elements are arranged *parallel* to each other with their light reflective surfaces parallel to each other (PN. 5,311,360, column 3, line 32 – 37). In an individual grating, all the elements are of the *same dimension* and are arranged *parallel to* one another with the spacing between adjacent elements equal to the beam width (PN. 5,311,360, column 5, line 26 – 29). The diffracted beams in the diffracting state remain as *plane waves* (PN. 5,311,360, 28, Figure 4). Furthermore, the commercial name for Bloom's diffractive grating modulator is called Grating Light Valve or GLV (Silicon Light Machines, CA, USA), undoubtedly further identifying that Bloom's diffractive modulator is based upon diffractive gratings.

In contrast, the wave modulating device claimed by the Applicant comprises of a very different optical element, *the Fresnel zone plate,* serving as *a lens*. The reflecting surfaces on the zone plate are in the form of *concentric circular* reflective zones with the radii of the zones determined by the zone plate equation. The wave modulating device produces a *focused beam* in the diffracting state with its focal point being at a distance *F* from the center of the zone plate. Such a result is *not physically possible* with Bloom's diffractive grating modulator.

In many lithographic or imaging applications, focused beams are required. U.S. Patent Application 10/708,778, filed by the Applicant on March 24, 2004, describes many examples of such applications. The wave modulating device disclosed by the Applicant can perform both the *modulation* and *focusing* functions in a single device. This is to be contrasted with the Bloom's diffractive grating modulator which is not capable of focusing beams. This problem of Bloom's diffractive grating modulator is clearly shown by D. Gil et al (G. Gil et al, *Journal of Vacuum Science and Technology* B, Vol. 20(6), p2597, Nov/Dec 2002, which is provided with the IDS). In order to produce focused

beams, D. Gil et al had to use a lens array placed after the Bloom's diffractive grating modulator, as shown in Figure 1 of the reference.

With regard to claim 17, 18, 20, and 29, Bloom et al did not teach how a 2D array based on the diffractive grating modulator would be constructed and used. In fact, such a 2D array is inoperative. Attempts for implementing such 2D arrays based on Bloom's diffractive grating modulator *failed commercially* as shown by Attachment #1. Therefore, only 1D arrays of diffractive grating modulators are commercially available.

The reason for the failure is, as indicated in Figure 3a and Figure 3b, that only the *small central region* of the *long* grating elements, when deflected, are sufficiently flat to be used as gratings. The remaining large regions of the long grating elements are merely used as *supporting beams*, and can not be used as reflecting surfaces. When such diffractive grating modulators are arranged into a 2D array, the usable region (fill factor) of the 2D array, as shown in Figure 3b, is so small that it renders the 2D array unusable. Chapter 20.4.3.4 of the Attachment #2 provides detailed discussion of this particular issue.

In contrast, the wave modulating device claimed by the Applicant has a symmetrical design with a fill factor larger than 78%. Therefore, a 2D array of the wave modulating devices is practical, and overcomes the problem faced by Bloom's diffractive grating modulators.

The pending claims 1-2, 4, 14-16, 17-18, 20, 22-24, and 28-29 contain limitations and elements not disclosed by the patent issued to Bloom et al (PN. 5,311,360), and therefore overcome the rejection over the reference. It was also entirely unexpected that such exceptional capabilities of being able to perform both the modulating and focusing functions could be obtained in a diffractive grating modulator. Reconsideration of this rejection is requested.

The objection to claim rejection as being unpatentable under §103 over the patents issued to Bloom et al and Greywall

Claims 5-13 and 25 were rejected under 35 USC 103(b) as being unpatentable over the patent issued to Bloom et al (PN 5,311,360) in view of the patent issued to Greywall (PN. 5684631).

Claims 5-7, 10, 12, 13, and 25 are dependent claims. They are patentable for the same reasons given with respect to their parent claims. They are even more patentable because they add more limitations. Reconsideration of this rejection is requested.

The objection to claim rejection as being unpatentable under §103 over the patent issued to Bloom et al

Claims 21, 26-27, and 30 are rejected under 35 USC 103(a) as being unpatentable over the patent issued to Bloom et al (PN. 5,311,360).

Claims 26 and 27 are dependent claims. They are patentable for the same reasons given with respect to their parent claims. They are even more patentable because they add more limitations. Reconsideration of this rejection is requested.

Conclusion

For all the above reasons, the Applicant submits that the specification and claims are now in proper form, and the claims all define patentably over the

prior art because that the present invention contains limitations and elements not disclosed by the prior art, and that the present invention provides results that were unexpected and are not possible by the prior art. Therefore, the Application submits that this application is in condition for allowance. Notice of Allowance is requested.

Conditional request for constructive assistance

The Applicant has amended the specification and claims of this application so that they are proper, definite, and define novel structure which is also unobvious. If, for any reason that this application is not believed to be in full condition for allowance, the Applicant respectfully requests the constructive assistance and suggestions of the examiner pursuant to M.P. E. P. §2173.02 and §707.07(j) in order that the undersigned can place this application in allowable condition as soon as possible and without the need for further proceedings.

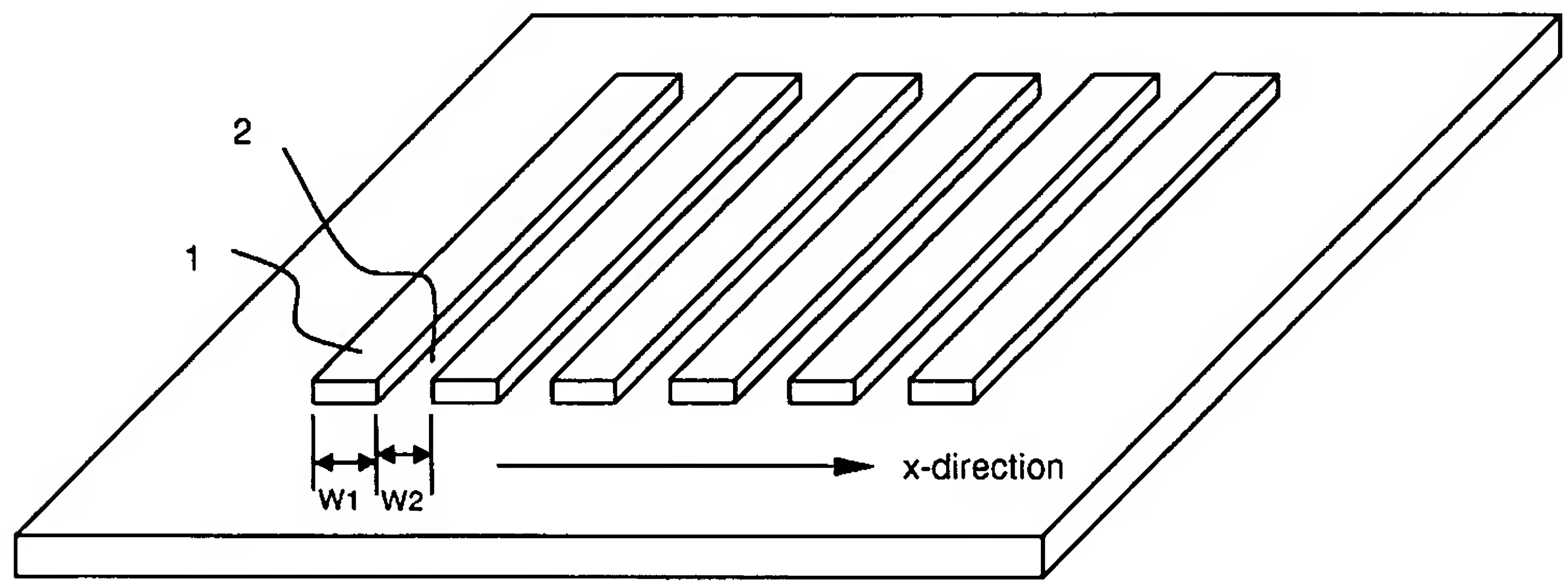

Figure 1a. A perspective view of a diffractive grating consisting of the repetitive elongated Element 1 and 2. The total width of the 2 elements W1 + W2 = constant.

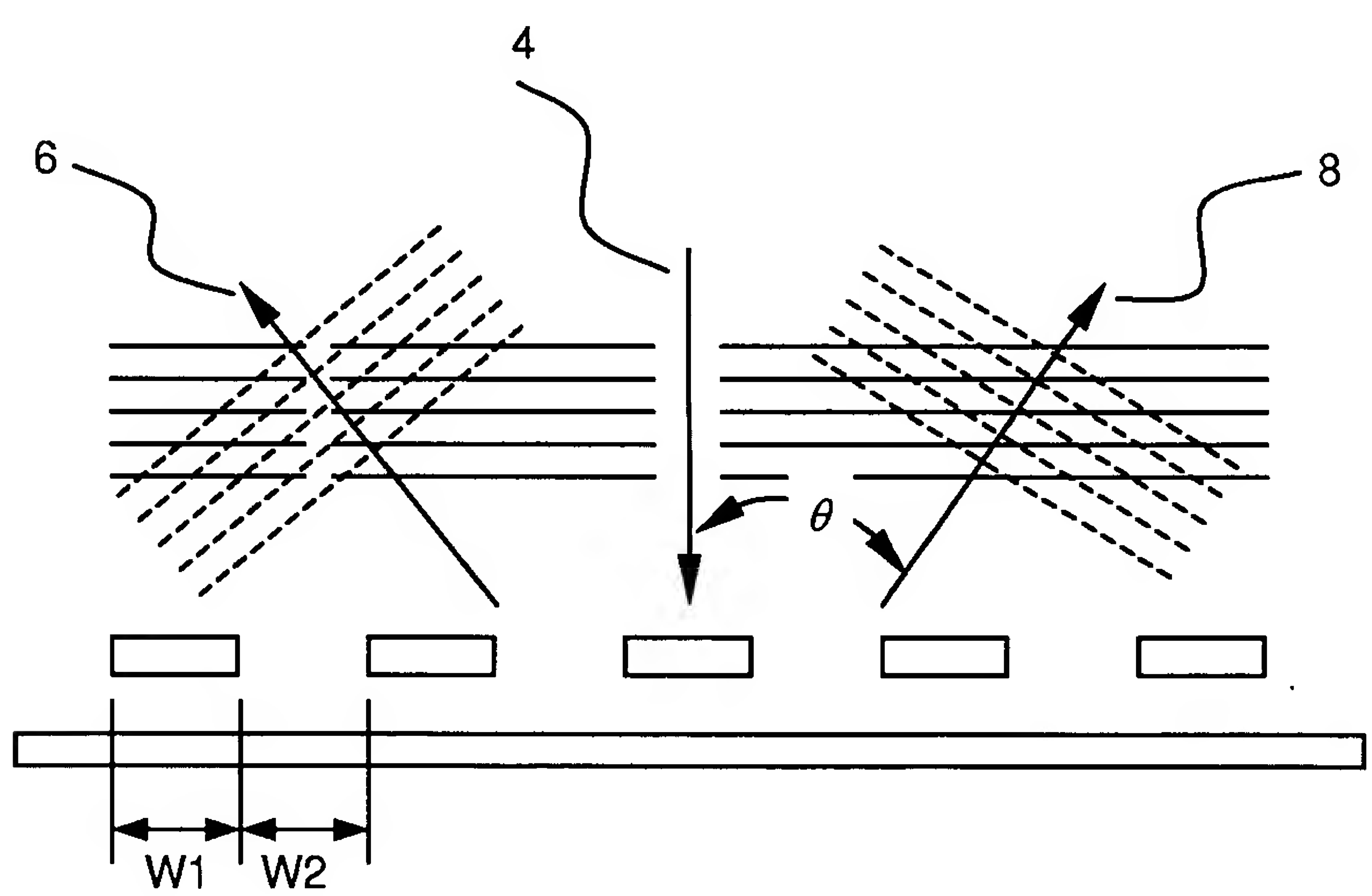

Figure 1b. A diffractive grating diffracts the incoming wave 4 into +1 order plane wave 6 and -1 order plane wave 8.

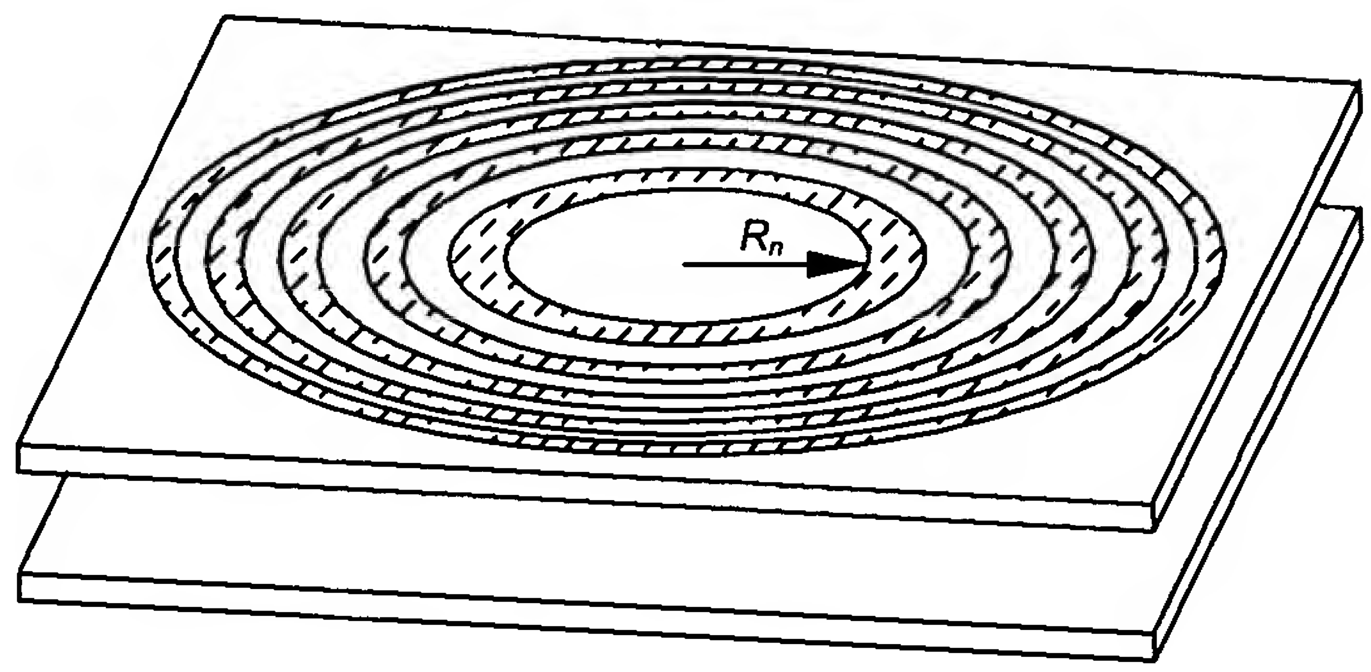

Figure 2a. A Fresnel zone plate where R_n, the radius of the nth zone, is determined by the zone plate equation.

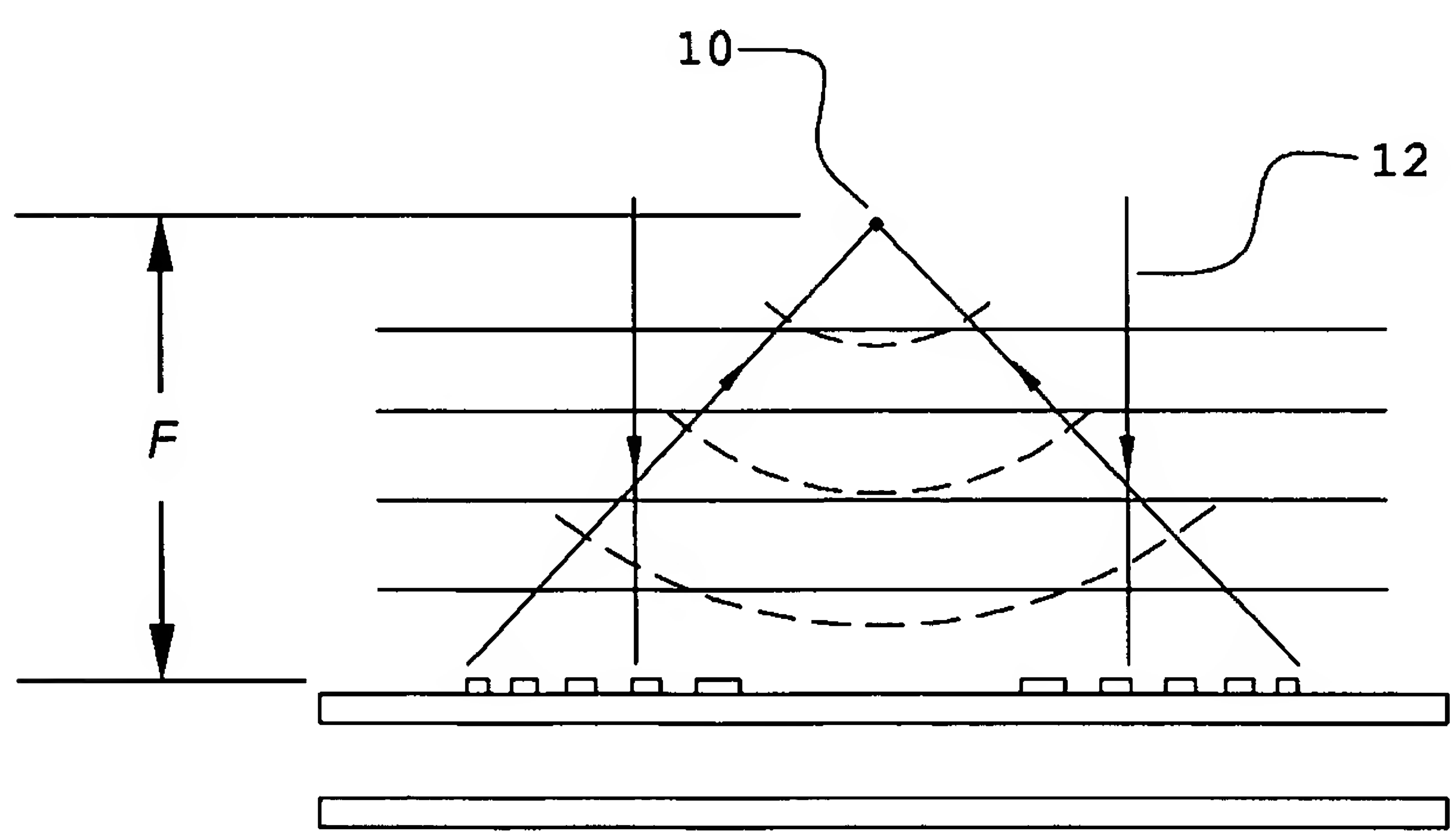

Figure 2b. A Fresnel zone plate functions as a lens and focuses the incoming wave 12 into a focal point 10. F is the focal point of the zone plate.

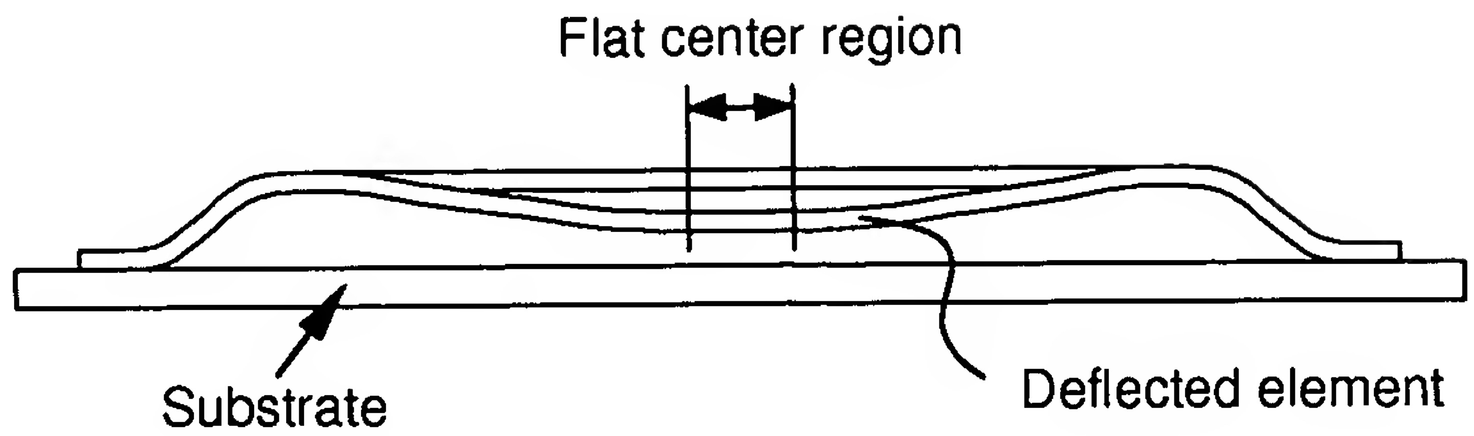

Figure 3a. A diffractive grating modulator in the deflected state. Only the small central region of the deflected element can be used for diffracting waves.

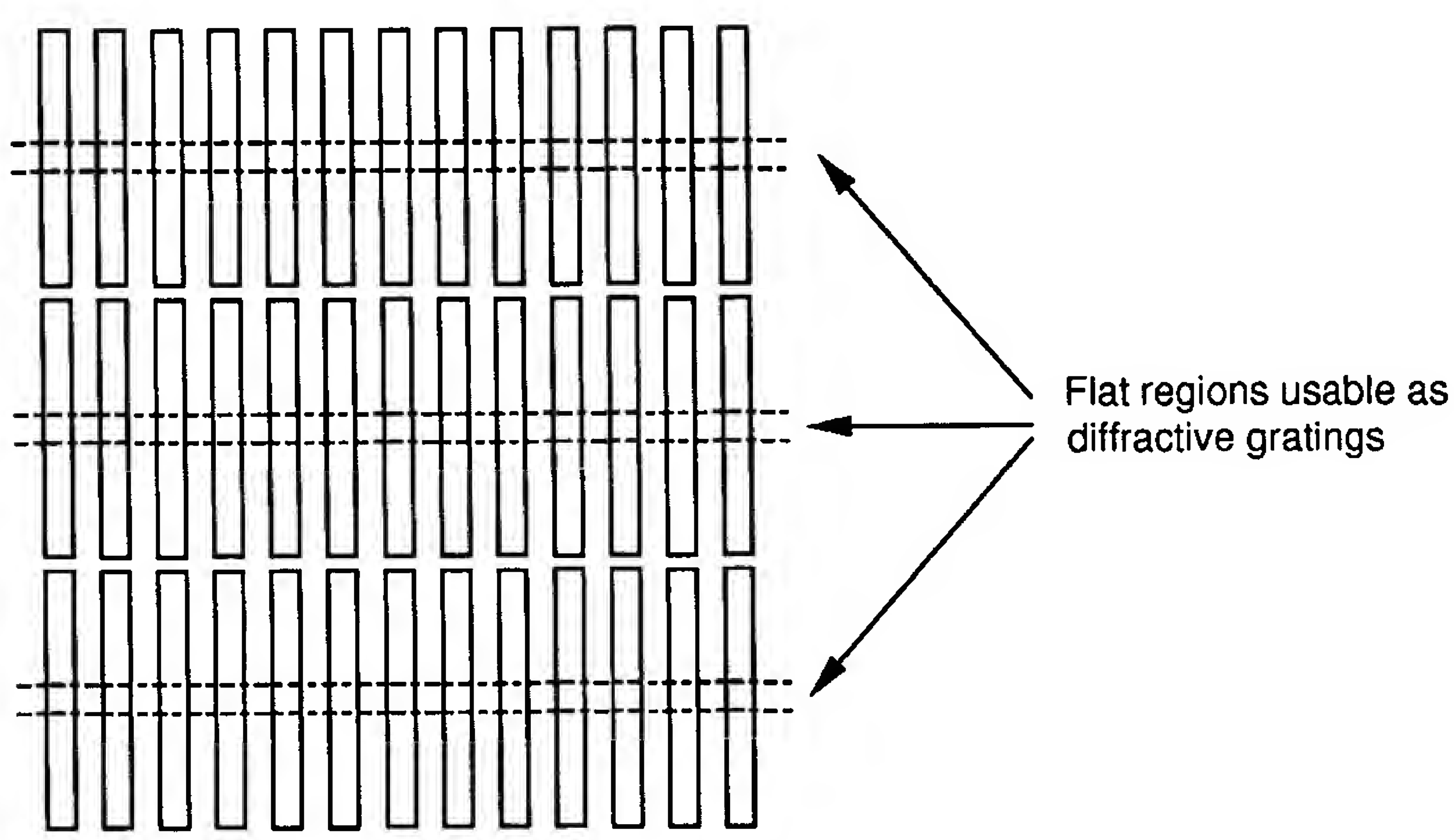

Figure 3b. Top view of an example two-dimensional diffractive grating modulator having three rows of linear diffractive grating modulators. Only the small central flat regions can be used for diffracting waves, therefore severely reducing the fill factor.

Very respectfully,

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Date: 2005 August 13

Inventor's Signature: Baokang Bi

Attachments

Attachment #1:

Growing pains beset miniature-display industry, written By David Lieberman, http://www.eetimes.com/news/97/966news/growing.html. The relevant paragraph is underlined.

Atachment #2:

Chapter 4.20.3.4, *Microsystem Design*, edited by Stephen D. Senturia, Kluwer Academic Publisher, Boston, 2000